

OPERATING INSTRUCTIONS

for the

ALLEN

**MODEL E-306
COMBUSTION ANALYZER**

**ALLEN EQUIPMENT CORRECTLY OPERATED
MEANS MORE SATISFIED CUSTOMERS**



ALLEN ELECTRIC and EQUIPMENT COMPANY • KALAMAZOO, MICHIGAN

PRICE
50 CENTS

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11. 12. 13. 14. 15. 16. 17. 18. 19. 20.

OPERATING INSTRUCTIONS

FOR THE

ALLEN E-306

COMBUSTION ANALYZER



USE THE FOLLOWING:

1 TAIL PIPE ELEMENT WITH ATACHING CABLE

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PRICE 50¢

ALLEN ELECTRIC AND EQUIPMENT COMPANY

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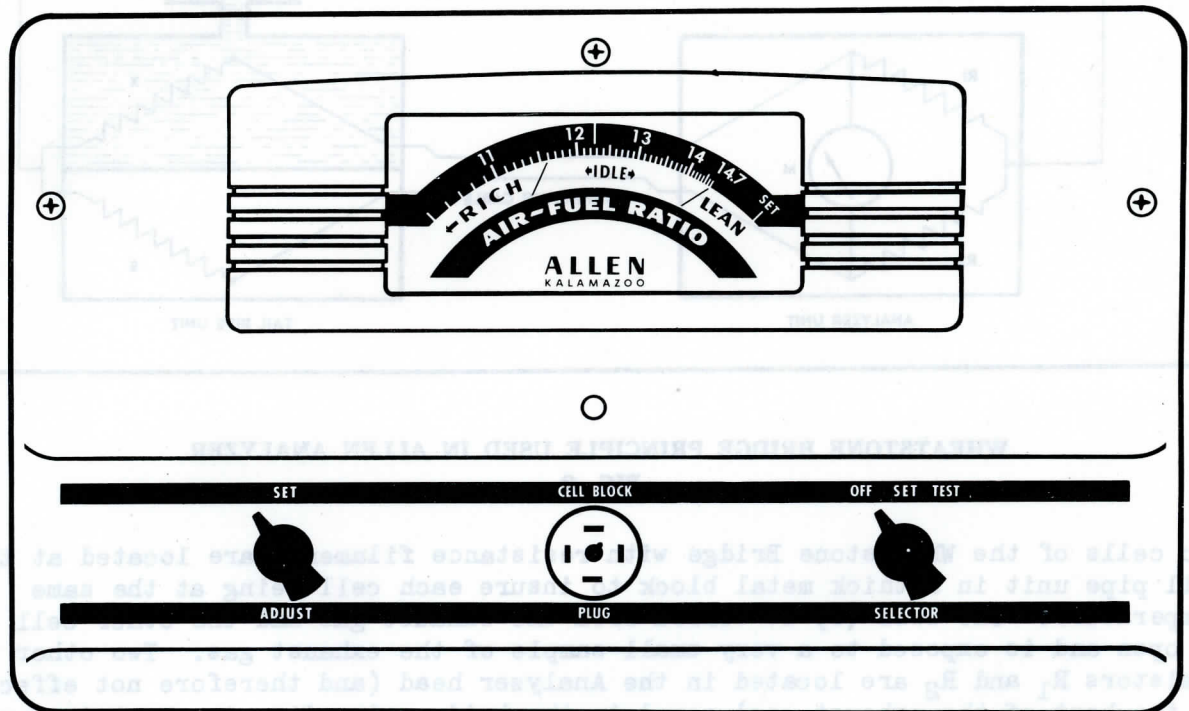
THE MODEL E-306 COMBUSTION ANALYZER

PURPOSE OF THE ANALYZER

The Allen Model E-306 Combustion Analyzer provides the quickest and most accurate method of making carburetor adjustments by using a Thermal Conductivity cell for measuring AIR-FUEL RATIO.

The Analyzer operates from three 1.5 volt flashlight cells located in the analyzer case. Electrical connection is made between the tail pipe unit and the analyzer unit which makes road testing practical and permits accurate instantaneous readings. No A.C. supply or hose connections are necessary.

Elimination of the hose to conduct the exhaust gas from the tail pipe to the analyzer and replacing it by electrical cable has eliminated the hazard of exhaust gases in the driving compartment when road testing, and has greatly reduced the time necessary for changes in exhaust gas to register on the meter scale. Also, any number of engines can be tested in succession and accurate readings obtained without the necessity of removing and draining of an exhaust hose between the tests.



FRONT PANEL MODEL E-306 ANALYZER

FIG. 1

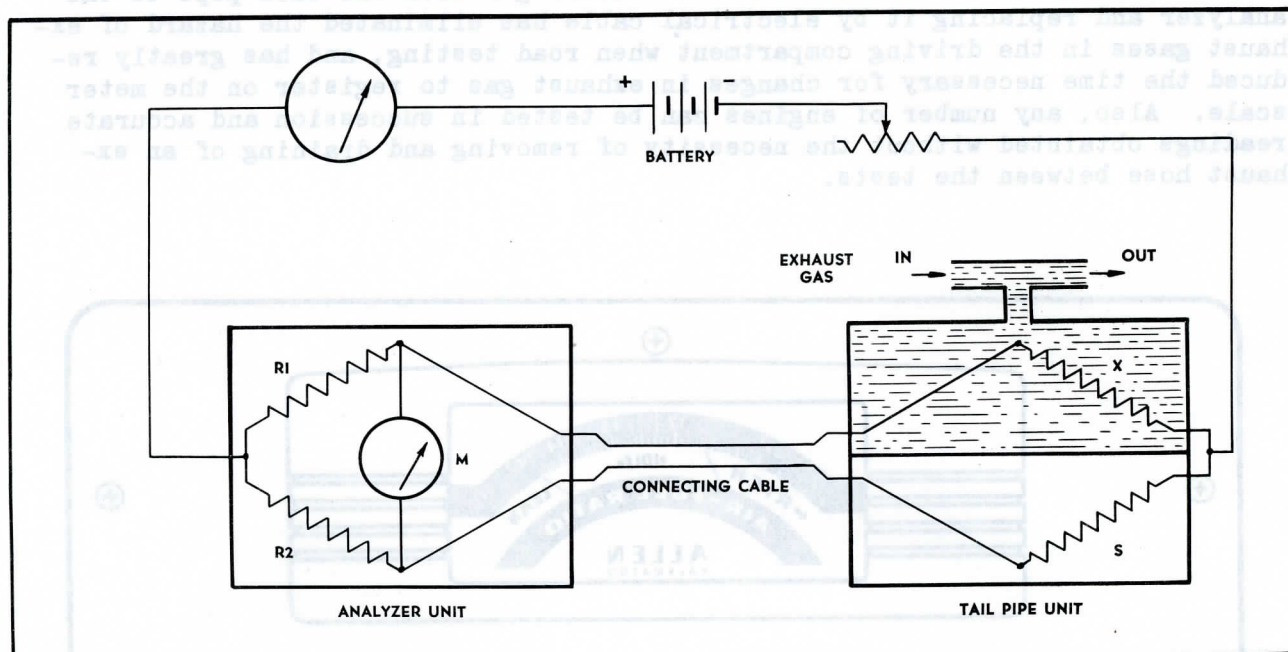
METER SCALE

The Analyzer measures AIR-FUEL RATIO and is calibrated from 11 to 14.7. For example, when the meter reads "14" on the AIR-FUEL RATIO scale, it means that 14 pounds of air, and 1 pound of fuel are entering the intake manifold.

THE MODEL E-306 COMBUSTION ANALYZER

PRINCIPAL OF OPERATION

The Allen Model E-306 Combustion Analyzer employs the Thermal Conductivity method of determining AIR-FUEL RATIO. This method depends on the fact that different composition of gases have different values of heat transmission or Thermal Conductivity. Therefore, it becomes a simple matter of measuring the resistance of a heated conductor exposed to air and comparing its resistance with a like heated conductor exposed to the exhaust gas. The resistance is measured by means of a Wheatstone Bridge circuit which responds to any small changes in resistance caused by the Thermal Conductivity of the gas.



WHEATSTONE BRIDGE PRINCIPLE USED IN ALLEN ANALYZER

FIG. 2

Two cells of the Wheatstone Bridge with resistance filaments are located at the tail pipe unit in a thick metal block to insure each cell being at the same temperature. One cell (S) is sealed from the exhaust gas and the other cell (X) is open and is exposed to a very small sample of the exhaust gas. Two other resistors R_1 and R_2 are located in the Analyzer head (and therefore not effected by the heat of the exhaust gas) complete the bridge circuit. An electric current from the battery flows through the bridge which heats the filaments (X) and (S) which in turn lose heat to the walls of the cells. When there is no exhaust gas in cell (X), the bridge is in balance and no current flows in the bridge circuit.

When a sample of the gas enters the open cell (X), the difference in Thermal Conductivity between the air in the sealed cell and the exhaust gas in the open cell causes the filament in the open cell to vary in temperature in relation to the Thermal Conductivity of the gas. The change in temperature causes a corresponding change in the resistance of the open cell which unbalances the Wheatstone Bridge producing a current flow through the galvanometer (M). The amount of current flow is a measure of Thermal Conductivity of the exhaust gas, and as Thermal Conductivity is proportional to AIR-FUEL RATIO, the amount of current as registered on the galvanometer is a direct indication of the AIR-FUEL RATIO.

THE MODEL E-306 COMBUSTION ANALYZER

PRINCIPAL OF OPERATION - (CONTINUED)

The Allen exhaust gas analyzer is practically free from effects of velocity of the gas sample. This is made possible by means of a special diffusion chamber which also cools the gas and removes excess water vapor.

LEAN MIXTURES

Various gasolines, with different carbon content, will show slightly different readings, but the average for regular brands of gasoline should not vary more than .3 AIR-FUEL RATIO. Benzol blends, due to a greater change in carbon content, make the scale reading show toward the rich side.

The lean side limitations of any Wheatstone Bridge analyzer, if it is accurate, is approximately 14.7 to 1, as at that ratio sufficient air is mixed with the fuel to burn all the gas, and any increase in the number of parts of air will send free oxygen through the engine. This condition changes the Thermal Conductivity of the gas cell and tends to reverse the reading.

Therefore, while the carburetor may be set to supply the engine with a leaner mixture than 14.7 to 1, and with some gasolines some of the present day engines may perform successfully on a higher AIR-FUEL RATIO. The Combustion Analyzer can only measure percentage of complete combustion up to the point where all the oxygen in the air going through the carburetor is burned with all the gas mixed with it. After this point the instrument should reverse because of the free oxygen passing through the engine, which tends to bring the galvanometer needle back to balance, or toward the rich side of the scale.

The Allen Combustion Analyzer is calibrated to indicate complete or 100% combustion at an AIR-FUEL RATIO of 14.7 to 1. Any Combustion Analyzer that registers an AIR-FUEL RATIO greatly in excess of these figures does not accurately analyze the sample of exhaust gases.

To properly use the Allen Combustion Analyzer, after all units pertaining to carburetion are correctly adjusted, the test should be made by carefully noting the advance of the meter needle from the rich to the lean side up to its highest reading. Beyond that, the reading is inaccurate as the needle will reverse, and indicate a richer reading as the mixture is leaned out with excess oxygen. It can be determined whether the analyzer reading has reversed by choking the carburetor with the choke valve to obtain a richer mixture and observing the direction of movement of the analyzer reading.

PROCEDURE FOR TESTING CARBURETION

CONNECTIONS

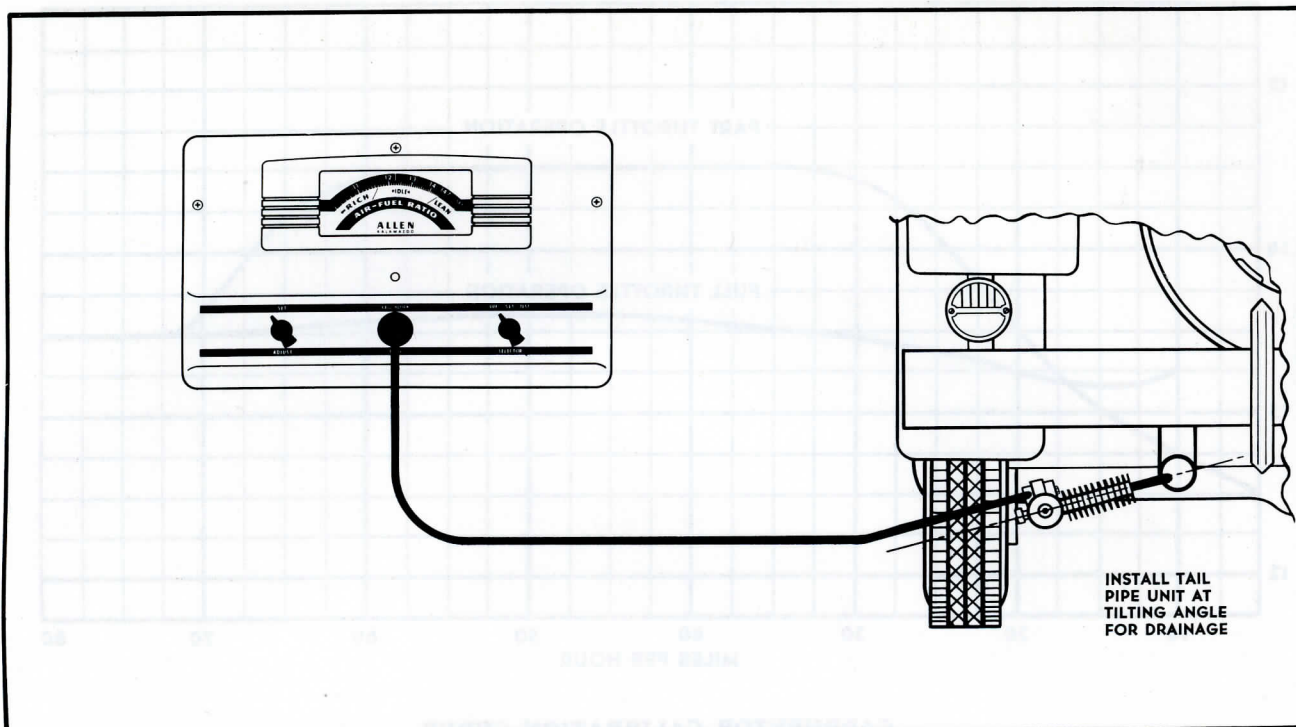
1. Insert the nozzle of the tail pipe unit into the vehicle tail pipe and clamp in place with the side marked TOP at the top. Install at tilting angle for drainage. Figure No. 3.
2. Plug the cable from tail pipe unit into cell block plug socket on tester panel.
3. Operate engine until normal operating temperature is reached.
4. Turn SELECTOR control to SET position.
5. Adjust VOLTAGE SET control until pointer on meter rests on the line marked SET. If meter pointer cannot be adjusted to the SET line on meter scale replace the three 1.5 volt flashlight cells in the tester.
6. Turn SELECTOR control to TEST position.

CARBURETOR IDLING TEST

7. With a vacuum gauge connected to the intake manifold, and with the engine running at 475 R.P.M. the vacuum gauge pointer should hold practically steady, at between 17 to 22 inches of vacuum and the analyzer meter should read between 11.5 to 13.0 to 1 AIR-FUEL RATIO. The average reading is about 12.5 to 1.
8. If the vacuum and combustion analyzer readings do not come within the limits mentioned above, adjustment of the carburetor idle adjusting screw at 475 R.P.M. should be made to see if a minor adjustment will bring the reading to normal. For most economical operation, the carburetor idle air screw should be adjusted as close to an AIR-FUEL RATIO of 13 to 1 as is possible without stalling or unnecessary roughness of the engine.
9. If it is impossible to obtain the correct AIR-FUEL RATIO the carburetor requires repair. A carburetor in standard condition will read between 11.5 and 13.0 to 1 AIR-FUEL RATIO when the carburetor idling screw is set within factory limits.

ACCELERATING PUMP TEST

10. If the carburetor is equipped with an accelerating pump, operate the engine at about 2000 R.P.M. and then quickly push the accelerator to the floor and then rapidly release the accelerator and observe the action of the analyzer meter. The meter pointer should move toward the rich side of the scale immediately after this accelerating action. If meter pointer fails to move toward the rich side or moves toward the lean side of the scale, it is an indication that the accelerating pump is not working properly, and adjustment or repair is necessary.



CONNECTIONS FROM ANALYZER TO TAIL PIPE UNIT

FIG. 3

HIGH SPEED SYSTEM

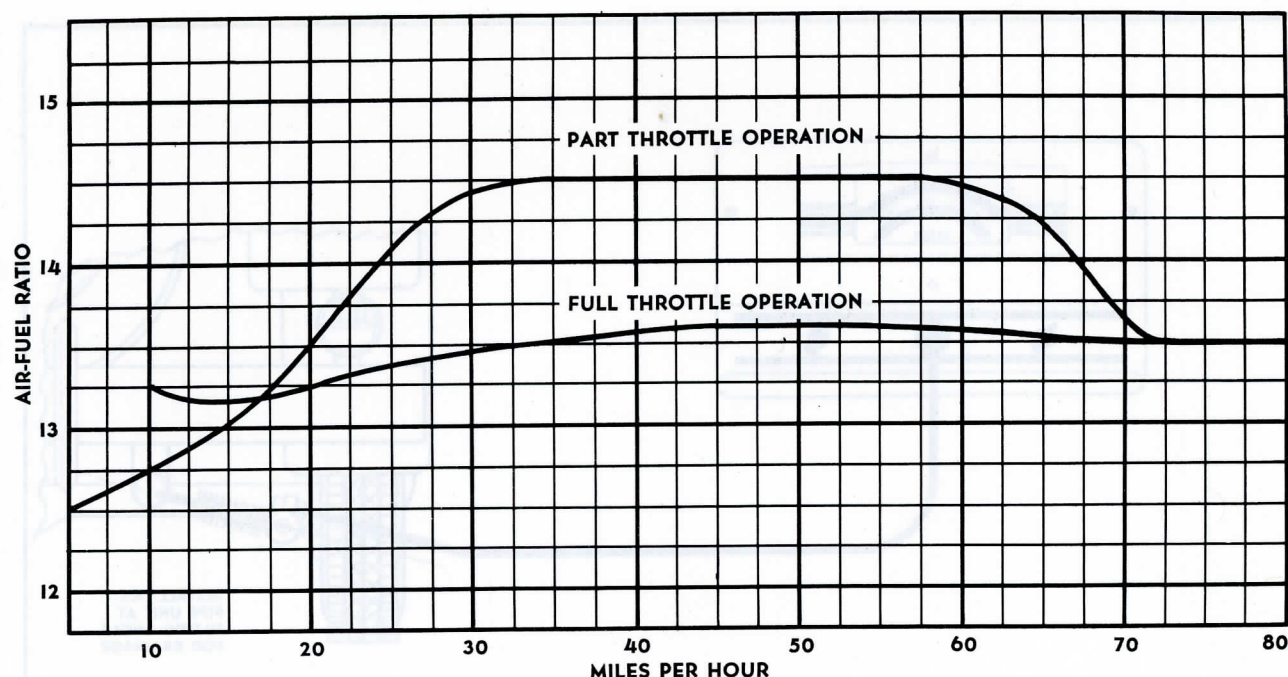
11. Adjust the throttle for an engine speed of 2000 R.P.M. The analyzer meter should read between 12.5 and 14.5 on the AIR-FUEL RATIO scale. On some vehicles, the AIR-FUEL RATIO reading may be lower than at idling speed. If the carburetor runs richer than normal as compared to other vehicles of the same make and model, remove the air cleaner to determine whether the air cleaner or carburetor is at fault. If the carburetor runs rich with the air cleaner removed it may indicate trouble in the carburetor. If the reading is normal with the air cleaner removed, it indicates a restricted air cleaner.

To obtain accurate readings at high speed, it is necessary to operate the engine under load by driving the vehicle on the road or on a Dynamometer, because the throttle opening is much less for the same engine R.P.M. when the engine is not under load than when it is propelling the vehicle.

CARBURETOR CALIBRATION

Carburetors regardless of type are all designed to supply the engine with a mixture of air and gasoline to give best power and economy over a wide range of engine speeds and loads and the calibrations or settings, are designed for correct average operation. Inasmuch as unusual operating conditions may exist, they are designed to allow calibration changes when necessary. However, calibration changes in the carburetor should never be made without the recommendation of the engine manufacturer. Changing carburetor calibration can prove very costly as over-rich mixtures or over-lean mixtures are detrimental to economy, power, and long engine life.

Over-rich mixtures waste gasoline and have a tendency to increase engine wear by washing lubricant from cylinder walls and by diluting the crank case oil. Excessively lean carburetion results in poor economy because of loss of power. It also causes flat spots in acceleration, and a tendency toward burned valves and spark plugs.



CARBURETOR CALIBRATION CURVE

FIG. 4

In general, carburetors are calibrated to furnish AIR-FUEL RATIOS similar to those shown in Figure No. 4. It can be noted that full throttle mixtures are richer than those at part throttle. This variation permits maximum power at wide open throttle and maximum economy under part throttle cruising or road load conditions. THE CURVES SHOWN ARE TYPICAL AND NO EFFORT SHOULD BE MADE TO OBTAIN THE READINGS INDICATED AS ACTUAL READINGS WILL DEPEND UPON THE DESIGN OF THE ENGINE AND THE COMPOSITION OF THE FUEL.

USE OF EXHAUST GAS ANALYZER

It is recommended that the exhaust gas analyzer be used in conjunction with a tachometer for measuring engine speed and a vacuum gauge for measuring engine vacuum.

Do not attempt to use the analyzer for redesigning the carburetor to obtain richer or leaner AIR-FUEL RATIOS than is obtained by using the standard carburetor furnished by the vehicle manufacturer. The vehicle manufactures have good reason for establishing a certain carburetor calibration and the exhaust gas analyzer is an invaluable instrument for determining whether any changes have taken place in the carburetor from its original design.

It is recommended that exhaust gas analyzer readings be taken on three or more vehicles of the same make and model at definite engine speeds to establish original readings at 475 and 2000 R.P.M. A reading different from the normal average indicates that the carburetor is in need of adjustment or repair.

Carburetor idle adjustments should be checked at all inspection and tune up periods with the aid of the exhaust gas analyzer. For most economical operation the carburetor idle air screw should be adjusted as close to an air fuel ratio of 13 to 1 as is possible without stalling or unnecessary roughness of the engine.

The Combustion Analyzer should always be used after engine and carburetor repairs have been completed, as a final check on the carburetor, before the vehicle is delivered to the owner.

CONDITIONS AFFECTING CARBURETION

Fuel is converted into power by the combustion of fuel and air. Combustion is the burning of a mixture of air and fuel in an engine, and is affected by three separate motor functions, COMPRESSION, IGNITION, and CARBURETION.

FUEL PUMP

A fuel pump not delivering sufficient fuel will cause a lean mixture. Check pressure and flow to determine if the pump meets with factory specifications. Too little flow will cause the engine to starve for fuel at high speed. Too high a pressure will force fuel past the float valve, resulting in a rich mixture. Check the fuel pump to see that it is operating according to manufacturer's specifications.

SPARK PLUGS

Incorrect or worn spark plugs, use more fuel because they will not completely fire the air-fuel mixture. Remove all the spark plugs and check to see if they are of the correct type and heat range. The selection of the proper type of spark plug for the driving conditions is important to both the life of the plugs and the performance of the engine. It is generally conceded that plugs be sold in complete sets and replacements made every 10,000 miles for best performance. Clean and re-gap plugs if they are serviceable.

AIR CLEANER

Carburetors are generally calibrated with the standard equipment air cleaner. Any variation in the gas analyzer readings obtained with and without the air cleaner installed does not necessarily indicate an abnormal condition. Air should always be kept clean by a periodic inspection and cleaning to insure proper operation.

MAINTENANCE

REPLACING BATTERIES

Three flashlight type D cells are contained in a compartment at the rear of the instrument chassis. Replacement is necessary when meter pointer cannot be adjusted to the SET line on the meter scale. DO NOT LEAVE DISCHARGED BATTERIES IN THE INSTRUMENT AS CORROSION MAY CAUSE SERIOUS DAMAGE TO THE CIRCUIT COMPONENTS.

1. Remove the three 6-32 screws from the front panel and the three 6-32 screws in the back of the case.
2. Pull complete chassis with front panel out of the case.
3. Replace worn-out batteries with fresh batteries of the same type, placing them in the instrument as originally installed.

MAINTENANCE —Continued

RECALIBRATING TAIL PIPE UNIT

After considerable use, the passage of exhaust gas through the cell block may leave a thin film of oil or carbon upon the walls and filament of the gas cell which changes the heat conductivity of the cell. With the analyzer meter pointer adjusted to SET and the tail pipe unit clear of all exhaust gas, the meter pointer should read within 1 meter division of being on the BALANCE point at the center of the meter scale when the SELECTOR switch is turned to the TEST position. If meter pointer is not within these limits, remove the upper chrome plated housing on the tail pipe unit and adjust one or both of the slotted screws extending through the side of the cell block until meter pointer rests on the 12.85 line in center of meter scale.

CLEANING GAS PASSAGES IN TAIL PIPE UNIT

If the gas passages in the tail pipe unit becomes restricted, the analyzer will become sluggish or erratic. This condition may be corrected by disassembling the tail pipe unit, by removing the red anodized parts and cleaning the openings so that the exhaust gas will pass through the tail pipe unit and into the gas cell block.

WRITING THE FACTORY

Should it be necessary to communicate with the factory, relative to your Combustion Analyzer, ALWAYS furnish its name, model number and serial number so that prompt and efficient attention can be rendered.



ALLEN ELECTRIC AND EQUIPMENT COMPANY
2101 N. PITCHER ST. KALAMAZOO, MICH., U.S.A.

CARE AND MAINTENANCE OF ELECTRICAL EQUIPMENT

1. DO NOT allow petroleum products, acids or alkalies, to come in contact with painted surfaces or plastic components.
2. Use a clean soft cloth for a DAILY dust cloth.
3. PLASTIC PANELS, LEADS AND SOCKS should be cleaned with MILD SOAP AND WATER.
4. SMALL SCRATCHES can sometimes be removed from plastic with rouge.
5. CORRODED TERMINALS can be cleaned with a solution of baking soda and water.
6. HEAT, generated in leads and clips, which becomes more than warm to the touch is a result of a poor connection and will result in an extra load being placed on the unit.
7. LARGE ranges have been placed on meters for heavy loads, SMALL ranges for finer reading. Always select the range large enough for the job, or damage will result.
8. IN MAKING ELECTRICAL CONNECTIONS, always watch the meter when you cause the current to flow; don't overload the meter. Use the proper shunt.
9. MOISTURE is second only to grease-and-dirt in shortening the life of electrical equipment. One of the less obvious ways in which moisture can damage equipment is to store in a non-heated area. Moisture can cause meters to stick, transformers to short, insulation and condensers to deteriorate.
10. METERS REQUIRING A POWER SUPPLY. A.C. or D.C. current may be required. It may be of a high or low voltage. Exercise caution in connection units to proper voltage source.
11. POWER TIMING LAMP. Its life will be greatly lengthened if disconnected when not in use.
12. POLARITY. Care should be exercised to see that units are not connected in reverse polarity.
13. In most cases, when units have been subjected to materials used in fire extinguishers, they may be considered beyond repair in making insurance adjustment.
14. SIX VOLT PLUG-IN RECEPTACLE UNITS will work better after a small amount of powdered graphite has been applied.
15. FANS. Units having a fan for cooling purposes cannot function well if covered, as air flow is restricted.
16. METERS exposed to the sun's rays for long periods of time will fade.
17. GROWLERS should not be turned "ON" unless first an armature has been placed into position to test.
18. UNITS USING FLASHLIGHT BATTERIES should be turned to the "OFF" position when not in use. When the batteries become discharged they should be removed at once, or damage will result.
19. IN EACH INSTANCE, REFER TO THE INSTRUCTION MANUAL BEFORE ATTEMPTING TO OPERATE. MINOR CHANGES HAVE SOMETIMES BEEN MADE, AND NEW MODELS MAY OPERATE DIFFERENTLY THAN PREVIOUS ONES.

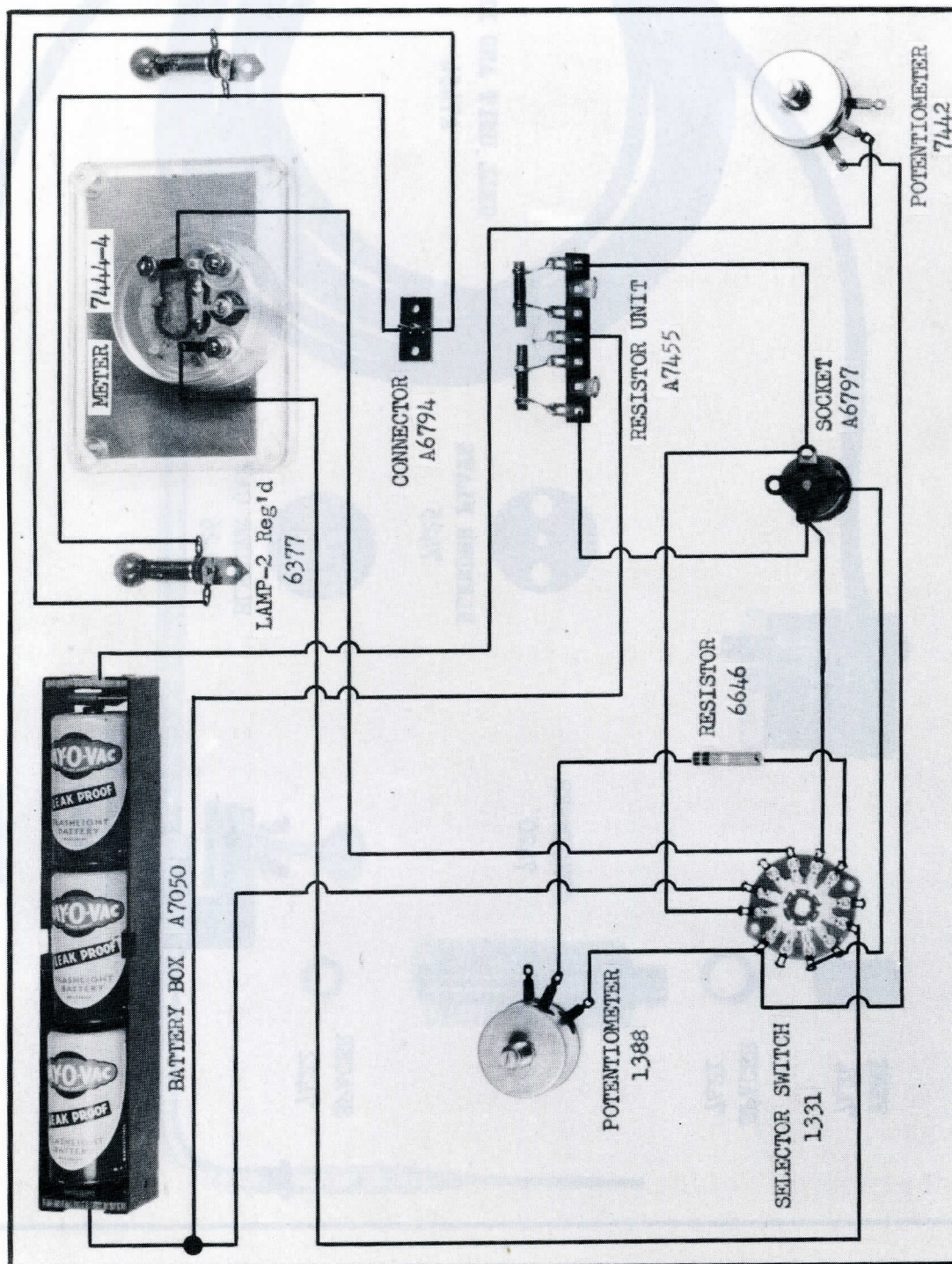
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ALLEN ELECTRIC AND EQUIPMENT COMPANY

E-306 COMBUSTION ANALYZER REPLACEMENT PARTS LIST

AND SCHEMATIC CIRCUIT DIAGRAM

NOTE: SPECIFY MODEL AND SERIAL NUMBER OF EQUIPMENT FOR WHICH PARTS ARE DESIRED. THIS IS ESSENTIAL FOR PROMPT HANDLING OF YOUR ORDER.



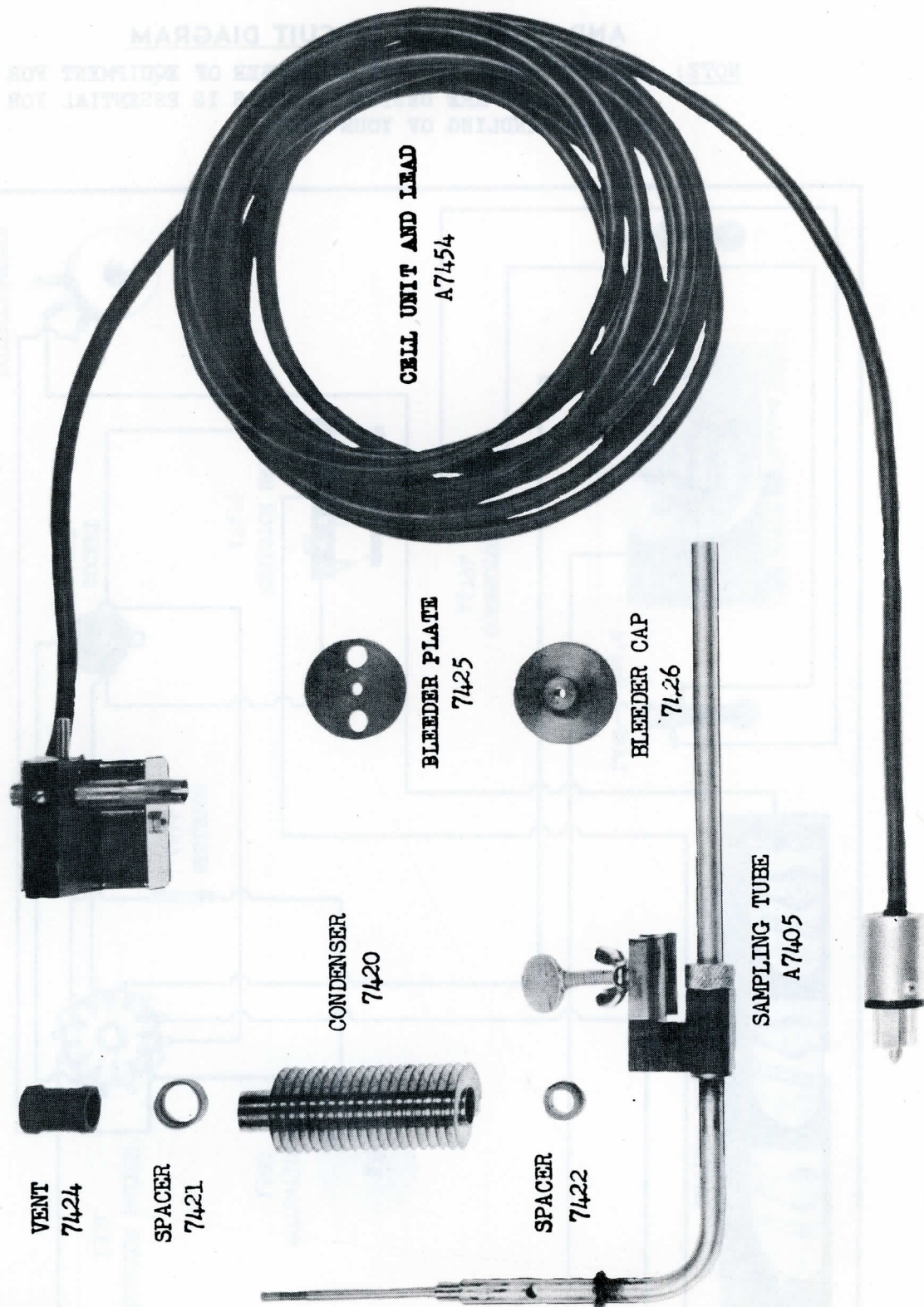
(ILLUSTRATION IS THE SCHEMATIC VIEW FROM BACK OF UNIT.)

E-306

9-2-47

ALLEN ELECTRIC AND EQUIPMENT COMPANY

**SAMPLING TUBE - CELL UNIT
COMPLETE ASSEMBLY
A7458**



ALLEN ELECTRIC AND EQUIPMENT COMPANY

2101 N. PITCHER STREET

KALAMAZOO, MICHIGAN, U. S. A.

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REPLACEMENT PARTS LIST

E-306 COMBUSTION TESTER

<u>PART</u>	<u>DESCRIPTION</u>	<u>PART NO.</u>
Battery Box	1½ Volt Cell Holder	A7050
Box	Sheet Metal	A6431-1
Bumper	Rubber (4 Required)	6847
Bleeder Cap	Aluminum	7426
Bleeder Plate	Aluminum	7425
Cell	1½ Volt Dry Cell (3 Required)	1337
Cell Unit & Lead & Plug		A7454
Condenser	Trufin Tubing Copper	7420
Connector	(Meter Lights)	A6794
Handle	Bakelite	6265
Knob	Bakelite (2 Required)	2379
Lamp	T-55 (2 Required)	6377
Lamp Housing	(Meter Lighting)	A6485
Meter	Plastic Cased	7444-4
Panel	(Front Panel)	6269-5
Plug Button	Zero Adjust Hole Cover	6389
Potentiometer	30 Ohm	7442
Potentiometer	15,000 Ohm	1388
Resistor	5,100 Ohm	6646
Resistor Unit	(Special)	A7455
Sampling Tube	(Stainless Steel)	A7458
Selector Switch	(Wafer Type)	1331
Socket	Test Lead Connection	A6797
Spacer	Aluminum	7421
Spacer	Aluminum	7422
Vent	Aluminum	7424

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EQUIPMENT PARTS LIST

2-508 CONSTRUCTION TESTER

<u>PART NO.</u>	<u>DESCRIPTION</u>	<u>PART</u>
AV080	1/2 Volt Cell Holder	Battery Box
AS481-1	Steel Metal	Box
8847	Rubber (4 Required)	Washer
7426	Aluminum	Blender Cap
7425	Aluminum	Blender Plate
1837	1/2 Volt Dry Cell (2 Required)	Cell
AV484		Cell Unit & Lead & Plug
7420	Triffin Tubing Copper	Conductor
AS794	(Water Light)	Conductor
8265	Emulsion	Handle
3372	Emulsion (2 Required)	Knob
8277	1-25 (2 Required)	Knob
AS485	(Water Light)	Knob Housing
7444-4	Plastic Cased	Water
6230-6	(Front Panel)	Panel
8080	Auto Alloy Hole Cover	Plug Button
7443	20 Ohm	Potentiometer
1388	10,000 Ohm	Potentiometer
8848	5,100 Ohm	Resistor
AV485	(Special)	Resistor Unit
AV486	(Stainless Steel)	Sampling Tube
1831	(Water Type)	Water Meter
AS797	Test Lead Connector	Water
7421	Aluminum	Spacer
7422	Aluminum	Spacer
7424	Aluminum	Test

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